Applying the Pooled Mean Group Panel ARDL Technique to Analyse the Impact of Uncertainty on Economic Growth in the ASEAN-5

YONG SOOK LU[a*], GOH LIM THYE[a],
SHAHABUDIN SHARIFAH MUHAIRAH[b] AND SELVARAJAN SONIA KUMARI[b]

[a]*Department of Economics, Faculty of Business and Economics, University Malaya, Malaysia*
[b]*Department of Political Science, Public Administration and Development Studies,
Faculty of Business and Economics, University Malaya, Malaysia*

ABSTRACT

The correlation between uncertainty and economic growth is an interesting research topic that has attracted different views from many scholars. The present study aimed to empirically analyse the linkages among numerous uncertainties, such as; the uncertainty index (UI), the consumer price index (CPI), foreign direct investment inflows (FDI), trade openness (TO), innovation (INNO) on economic growth (GDP) in the ASEAN-5 countries: Malaysia, Indonesia, Singapore, The Philippines and Thailand between 1960 and 2020. The association between economic growth and its determinants over the long- and short-term was estimated using the pooled mean group (PMG) panel autoregressive distributed lag (ADRL) technique. The findings showed that all computed coefficients had predicted signs and were statistically significant in the long run. In addition, economic growth was significantly impacted by FDI and the uncertainty index, both in the short and long term. The uncertainty index, CPI, FDI, innovation, and economic growth, thus, had a unidirectional relationship. On the other hand, no reciprocal relationship existed between trade openness and economic growth for the ASEAN-5 nations.

JEL Classification: D8, O47, R11

Keywords: ASEAN 5; Economic Growth; Panel ARDL; Uncertainty

INTRODUCTION

The ten member nations of ASEAN are; Malaysia, Singapore, the Philippines, Brunei, Indonesia, Thailand, Vietnam, Myanmar, Cambodia and Laos. They are situated in a prosperous and dynamic world region encompassing a population of 700 million. The ASEAN nations have the chance to work together and enhance their respective social-economic conditions through upgrades to the region's communications and infrastructure chains as well as the flow of people, products and services (Tan and Tang, 2016: Malarvizhi et al., 2019). The table below shows the economic growth of the top five ASEAN nations that share similar cultural, social and economic values (Ifa et al., 2019). Table 1 presents the economic growth of these top five countries, referred to as the ASEAN-5 countries, for the past seven years.

Table 1 Economic Growth in the ASEAN-5 (GDP, Annual Variation in %)

	2015	2016	2017	2018	2019	2020	2021
Malaysia	5.1	4.4	5.8	4.8	4.3	0.5	5.5
Singapore	3.0	3.2	4.3	3.4	0.7	0.2	2.0
Thailand	3.1	3.4	4.1	4.2	2.4	-4.8	2.5
Indonesia	4.9	5.0	5.1	5.2	5.0	2.5	5.0
Philippines	6.3	7.1	6.9	6.3	6.0	2.0	6.5

Source: ADB (2020)

In recent years, uncertainty has increased and hampered the expansion of the Gross Domestic Product (GDP) (Haddow et al., 2013) and the global economy as a whole (Ahir et al., 2019). Uncertainty can arise due to various factors, such as; inflation, government policies, trade, politics, the exchange rate, etc. Many previous studies have found that a high uncertainty index has a detrimental effect on economic growth (Asteriou and Price, 2005; Sušjan and Redek, 2008; Bhagat et al., 2013). Hence, uncertainty's negative impact will threaten investors' and consumers' confidence. From an investment point of view, it will slow down foreign direct investment (FDI) flows to economies (Erramilli and D' Souza, 1995; Lemi and Asefa, 2003; Ajami, 2019). FDI is essential for a nation's development since it promotes capital inflows, expands employment opportunities and income and transfers technology and expertise to other countries. Besides, consumer confidence has been seen to be negatively impacted by uncertainty (Dalen et al., 2017). Hence, if such a condition persists, it will be detrimental to economic circulation since consumers may reduce spending, decreasing product supply and raising the unemployment rate. Therefore, this study investigated the effect of uncertainty on the economic growth of the ASEAN-5 countries.

The remainder of this paper is organised as follows: A literature review concerning several uncertainty factors that affect economic growth is covered in the next section. The third section contains a presentation of the data, methodology, and empirical model employed in this study. The fourth section covers the data analysis. Concluding observations and the study's limitations can be found in section five.

LITERATURE REVIEW

Generally, the greater the development and economic activity in a country, the higher its economic growth. The economic development of a country is influenced by various issues, such as; the uncertainty index, political stability, natural resources, inflation, foreign direct investment, trade, innovation, demographics, educational standards, employment levels, productivity, the exchange rate, the state of the global economy, fiscal and monetary policies, levels of infrastructure etc. This study proposed that economic uncertainty was measured by: the uncertainty index (UI), consumer price index (CPI), foreign direct investment (FDI) inflow, trade openness (TO) and innovation (INNO). These factors are discussed individually below:

Uncertainty

In order to show that the index serves as a proxy for changes in policy-related economic uncertainty, Baker et al. (2016) created a new index of economic policy uncertainty (EPU) based on newspaper coverage frequency. In policy-sensitive industries like defence, healthcare, finance, and infrastructure building, as well as other industries, they discovered that policy uncertainty is related to increased stock price volatility and decreased investment and employment. Policy uncertainty innovations portend decreases in investment, output, and

employment in the United States (US). Their result was almost identical to Jurado et al. (2015), who found that uncertainty was not driven by proxies but rather by independent variations from well-known uncertainty proxies. When it takes place, it is persistent, larger and more related to an actual situation. Round important occurrences globally such as the US's 2016 election, the UK's vote for Brexit, the European border crisis, El-Nino, the Euro debt crisis, Gulf War II, the SARS outbreak, the 9/11 attack and the COVID-19 pandemic, uncertainty index rises and brings a negative impact on economies. Due to their more closely knit financial and trade networks, advanced economies are more coordinated than emerging ones in terms of the level of uncertainty they are experiencing (Ahir et al., 2022).

A study by Barrero et al. (2017) looked into macro and firm-level uncertainty and displayed that uncertainty had both short- and long-run components. While short-term uncertainty was strongly correlated with oil price volatility, long-term uncertainty in firms was more closely associated with slow-moving and radical risks, such as those inherent in policy uncertainty. Other drivers of firm-level uncertainty included CEO turnover and exchange rate swings, which were almost equally related to short- and long-term uncertainty. These findings implied that recent developments that have increased long-term policy uncertainty might harm growth by lowering R&D and investment. Stock and Watson (2012) stated that the primary causes of the decline in output and employment during the 2007–2009 recession were caused by financial and unpredictability shocks.

In 2020 the world was shocked by the COVID-19 pandemic, which abruptly curtailed most countries' economic growth worldwide. Over the last two years, the world has been heavily impacted by the COVID-19 pandemic in almost every aspect, including; the economy, education, tourism, employment etc. This new strain of virus caused most countries to face a recession in 2020. The forecast of global GDP growth was -4.36 per cent in May 2020. It was the steepest downgrade of the global GDP since 1990 (World Bank, 2020). The COVID-19 pandemic also caused an estimated loss of USD 4 trillion to the worldwide GDP in 2020 and 2021 (UNCTAD, 2021). This estimated loss was mainly from the tourism industry, a major revenue contributor for most countries worldwide. Baker et al. (2020) also showed that COVID-19 reduced the US's GDP by 9 per cent in 2020 based on volatility response function and the initial stock market returns using vector autoregressive (VAR) estimation.

Foreign Direct Investment

Developed and developing nations have relied on foreign direct investment (FDI). Many economic studies have examined how foreign direct investment has affected economic growth. These studies have discovered positive and negative outcomes from foreign direct investment. Most economists and policymakers have credited FDI with capital stock appreciation, increased employment, and technology investments. On the other hand, there have been worries that FDI has hurt domestic investment and undermined local competition.

According to Lenka and Sharma (2014), who examined data from 62 countries between 1991 and 2010, FDI has been associated with economic growth. Similar results were discovered by Balasubramanyam et al. (1996), Li and Liu (2005), Chowdhury and Mavrotas (2006) and Banga (2006). Seyoum and Camargo (2020) investigated the relation between economic growth and FDI inflows of human capital and other strategies for enhancing economic effectiveness by sharing new technologies, marketing strategies, and management expertise. The results demonstrated that when FDI inflows were significant, national economic fragility may result in a country's economic collapse.

According to Aitekn and Harrison (1999), FDI in Venezuela did not appear to have any positive spillover effects. Additionally, FDI had no beneficial impact on economic growth in a developing nation like Morocco, according to Mansfield and Romeo in 1980. As a result, opinions on how much foreign direct investment will contribute to economic growth remain mixed.

Inflation

Numerous authors including Sarel (1995), Andres and Hernando (1997) and, Ghosh and Phillips (1998) have found that inflation has significantly negatively impacted economic growth. Fischer (1993) showed a negative correlation between growth and inflation in several different countries using cross-sectional time series data. Barro (1995, 1997) also reaffirmed this, but the relationship might not have been linear. According to the studies by Levine and Zervos (1993) and Sala-i-Martin (1994), there was little correlation between inflation and economic growth. As additional conditioning variables were added, inflation's significance decreased. The

overall findings of these studies, and those by Gregorio (1993) and Tien (2021), were in line with the theoretical literature's suggestion that there is a long-term negative association between inflation and income.

Trade Openness

Trade openness and economic growth have been closely correlated, although the evidence has been conflicting and inconclusive. Numerous studies have demonstrated the beneficial effects of trade openness on growth (Frankel and Romer, 1999; Dollar and Kraay, 2004; Freund and Bolaky, 2008; Chang et al., 2009). Other research (Vlastou, 2010; Polat et al., 2015; Musila and Yiheyis, 2015; Ulaşan, 2015) denied that trade and economic expansion are mutually beneficial. The econometric methods, the sample of nations, and the indicators employed as proxies for trade openness may have caused the empirical literature's contradictory findings. According to Huchet-Bourdon et al. (2018), countries that specialise in subpar goods may experience slower growth due to trade openness.

International trade benefits both exporting and importing countries' economies. Economic growth is positively impacted by global trade. Kavoussi (1984) asserted that a nation's capacity to grow its exports was closely related to the state of its overall economy. He found that growth in countries with a medium or low level of income is correlated with exports. According to Sachs and Warner (1995), in terms of real GDP growth, open emerging markets have performed better than closed emerging markets. Even in the poorest countries, trade liberalisation has favoured human capital and productivity (Harrison, 1996). The most underdeveloped countries, on the other hand, remain dependent on conventional agriculture and are more vulnerable to economic shocks.

Foster (2008) evaluated how trade liberalisation affected economic development using cross-sectional information. His research showed that trade liberalisation had short-term negative effects on economic growth but long-term positive effects on countries with low economic growth rates. Simorangkir (2006) used the structural vector autoregressive (SVAR) model to analyse the link between trade openness and economic expansion in the situation of Indonesia. His research indicated that trade and financial openness are harmful to economic growth and domestic GDP. This outcome demonstrated how a lack of product diversity in Indonesian markets led to low demand and poor domestic output. Jin (2006) looked into how Japan and Korea's economies and trade openness were related. Their investigation demonstrated that trade openness had a detrimental impact on economic expansion because of the financial markets' negative influence on macroeconomic performance.

Innovation

The association between innovation and economic growth first appeared in Solow's (1956) research, which discovered a long-term relationship between the two. Schumpeter (1912, 1939) contrasted between the concepts of economic development and growth. Thus, from his perspective, economic development was characterised by abrupt internal changes brought on by economic inventions that originated from the economic system, as opposed to economic growth, which reflects a slow and gradual changing of the economic system as a result of foreign forces. Empirical studies (Aghion et al., 2005, 2009) have supported Schumpeter's economic growth model's emphasis on the importance of education and innovation-based competitiveness in promoting the advancement of the economy.

Pece et al. (2015), Hu and Png (2013) and Chadee and Roxas (2013) employed macro- and micro-level of information and considering business, domestic, and global aspects to determine the relationship between economic expansion and innovation. Pessoa (2007) also investigated the relationship between innovation and economic expansion and found no evidence of a direct link between expenditure on research and development (R&D) and growth in the economy. Therefore, in addition to R&D expenditure, innovation strategy must also use additional indicators to account for this complexity.

DATA AND METHODOLOGY

This study's empirical objective was to investigate the impact of uncertainty on the economic growth of the ASEAN-5 countries. The empirical model of this study is as follows:

$$GDP = f(UI, CPI, FDI, TO, INNO) \tag{1}$$
$$GDP = b_0 + b_1 UI_{it} + b_2 CPI_{it} + b_3 FDI_{it} + b_4 TO_{it} + b_5 INNO_{it} + e_{it}, \; i = 1,\ldots,5; \; t = 1960, 2020 \tag{2}$$

where *GDP* represents the real GDP per capita as a proxy of economic growth. *UI* refers to the uncertainty index. *CPI* refers to the consumer price index, *FDI* represents foreign direct investment inflows, whereas *TO* and *INNO* represent the levels of trade openness and innovation, e_{it} is the error term of *i* country in *t* period.

Data analysis employed the panel Autoregressive Distributed Lag (ARDL) technique. In order to determine if the uncertainties had both long- and short-run consequences on the ASEAN-5 countries' economic expansion, Pesaran et al. (1999)'s pooled mean group (PMG) estimator was utilised. Thus, Equation 3, as follows, was estimated:

$$DGDP_{it} = \alpha + \sum_{j=1}^{k} \beta_{j2} DGDP_{i,t-j} + \sum_{j=0}^{k} \delta_{j2} DUI_{i,t-j} + \sum_{j=0}^{k} \theta_{j2} DCPI_{i,t-j} + \sum_{j=0}^{k} \rho_{j2} DFDI_{i,t-j}$$
$$+ \sum_{j=0}^{k} \varphi_{j2} DTO_{i,t-j} + \sum_{j=0}^{k} \omega_{j2} DINNO_{i,t-j} + \gamma ECT_{i,t-j} + \varepsilon_{it} \tag{3}$$

where $\beta_{j2}, \delta_{j2}, \theta_{j2}, \rho_{j2}, \varphi_{j2}, \omega_{j2}$ are the coefficients, ε_{it} is the white noise term, γ is the coefficient of the error correction term (ECT). Equation 4 below shows how the variables have been connected over a long period of time using the ECT:

$$ECT_{i,t-j} = GDP_{it} - \alpha - \sum_{j=1}^{k} \beta_{j1} GDP_{i,t-j} - \sum_{j=0}^{k} \delta_{j1} UI_{i,t-j} - \sum_{j=0}^{k} \theta_{j1} CPI_{i,t-j} - \sum_{j=0}^{k} \rho_{j1} FDI_{i,t-j}$$
$$- \sum_{j=0}^{k} \varphi_{j1} TO_{i,t-j} - \sum_{j=0}^{k} \omega_{j1} INNO_{i,t-j} \tag{4}$$

where $\beta_{j2}, \delta_{j2}, \theta_{j2}, \rho_{j2}, \varphi_{j2}, \omega_{j2}$ are the coefficients.

Testing Procedure

Relationship between factors affecting economic growth was examined applying various econometric techniques, focussing on the ASEAN-5 countries. This study first used descriptive and correlation statistics to examine how uncertainty affects economic growth. Next, the Pesaran cross-sectional dependence (Pesaran CD) test was utilised to assess the assertion that the time-series data were unrelated (Pesaran, 2004). It is essential to check for cross-sectional dependence in a panel study because failing to do so results in significant estimation bias.

This study took into account both long- and short-term interactions as well as the presence of nonlinearity. It employed the panel autoregressive distributed lag (ARDL) approach created by Pesaran et al. (1999) to evaluate the short- and long-term relationships. The common correlated effect pooled mean group (PMG) was employed to address the contemporaneous correlation problem.

Before performing the major estimates, this study first carried out panel unit root tests to examine if the variables were stationary or not. Several tests were carried out, including; the Im, Pesaran and Shin (IPS) (2003), Breitung (2000) and Levin, Lin, and Chu (LLC) (2002) unit root tests. These analyses all start with the null hypothesis of non-stationarity. The Bayesian-Schwarz criteria were used to determine the lag length.

Next, Pedroni's (1996) panel cointegration test was utilised to determine whether a long-term link existed. The cointegration coefficients were evaluated using the dynamic ordinary least squares (DOLS) and completely modified ordinary least squares (FMOLS) methods. If none of the earlier techniques revealed any evidence of cointegration, the pooled mean group panel ARDL was applied. It doesn't matter if the underlying regressors exhibit $I(0)$, $I(1)$, or a combination of both when a period is longer than 20 years; the macro panel data approach can be employed (Pesaran and Shin 1998). Then, the Wald test, commonly known as the Wald Chi-Squared Test, was applied to determine the significance of the explanatory variables in the model.

This empirical analysis's last stage examined whether economic growth and its determinants were causally related in both directions. Granger (1969) presented an approach in a landmark essay that examined the connection between time series that caused events. The Granger representation theorem indicates that two time series must have at least unidirectional causality in order for them to be cointegrated. This methodology was expanded by Dumitrescu and Hurlin (2012) to allow for the detection of causation in panel data if there is a single or two-way causal relationship between the two variables.

Data

The Association of Southeast Asian Nations (ASEAN) region, specifically Malaysia, Indonesia, Singapore, The Philippines, and Thailand, was the subject of this study which covered the period from 1960 to 2020. The uncertainty index (UI) was obtained from The International Monetary Fund's (IMF) and World Uncertainty Index (WUI) database. The inflation (CPI), trade openness (TO), foreign direct investment (FDI) inflows, innovation (INNO) and the real GDP per capita (GDP) were obtained from the World Development Indicators (WDI). All the variables were expressed in natural logarithms. The descriptive statistics and correlation of the datasets are presented in Tables 2 and 3.

Table 2 Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Max	Min
GDP	181	4.08	0.93	6.43	2.70
UI	181	-0.76	0.76	0.70	-3.39
CPI	181	4.01	0.88	5.02	0.84
FDI	181	0.75	1.33	3.47	-3.80
TO	181	4.64	0.71	6.08	3.62
INNO	181	6.54	1.81	9.55	0.69

Source: Calculated by Author.

Table 3 Correlation

	RGDPC	CPI	FDI	INNO	TO	UI
GDP	1.0000					
CPI	-0.0886	1.0000				
FDI	0.4537	0.6184	1.0000			
INNO	0.4211	0.3987	0.3962	1.0000		
TO	0.6343	0.4855	0.7964	0.3902	1.0000	
UI	-0.3699	-0.0351	-0.2046	-0.2499	-0.2372	1.0000

Source: Calculated by Author.

EMPIRICAL RESULTS

In panel analysis, the cross-sectional dependence test, also known as the Pesaran (2007) CD test, is crucial because estimation may be severely biased without it. The results in Table 4 showed cross-sectional dependence in the time series. This outcome meant that changes in; economic growth, the uncertainty index, CPI, FDI, trade openness and innovation that transpired in any of the examined ASEAN-5 nations also had an impact on other nations.

Table 4 Results of the Cross-section Dependence Test

Variables	t-statistic	p-value
GDP	23.7757	0.0000***
UI	2.7432	0.0061***
CPI	23.3725	0.0000***
FDI	5.4260	0.0000***
TO	17.8571	0.0000***
INNO	12.4615	0.0000***

Note: ***indicate rejection of the null hypothesis at the 1% significance level.

Source: Calculated by Author.

Next, stationarity checks were crucial since all of the predicted variables' integration orders should either be $I(0)$ or $I(1)$. The Im, Pesaran and Shin (2003), Breitung (2000) and Levin et al. (2002) unit root tests were used to look for signs of stationarity. The results of the above unit root tests are presented in Table 5.

Overall, the findings indicated that across all variables, the order of integration for the GDP, uncertainty, CPI, FDI, trade openness and innovation was either $I(0)$ or $I(1)$. Uncertainty and FDI were where the unit root null in level terms was vehemently rejected $I(0)$. However, all four other variables were $I(1)$ because the unit at first difference null was accepted. Due to the diverse levels of integration among the series, the panel ARDL approach was used in this study instead of the more traditional static or panel cointegration testing (Asteriou and Monastiriotis, 2004). Various benefits distinguish the panel ARDL approach. These benefits include the ability to estimate various variables with various orders of stationarity, as in the case of Table 5. This study also noted that the data exhibited $I(0)$ or $I(1)$. Additionally, these estimators enabled this study to estimate the error correction coefficient and the short- and long-term relationships.

Table 5 Panel Unit Root Tests

	Level			1st Difference		
	Im, Pesaran and Shin	Breitung	Levin, Lin, Chu	Im, Pesaran and Shin	Breitung	Levin, Lin, Chu
RGDPC	-2.3745	1.1267	-1.1878	-11.7230***	-2.2462***	-10.1256***
UI	-8.4676***	-6.9219***	-9.9262***	-19.2655***	-10.7066***	-16.8502***
CPI	-0.3899	5.5992	-1.8827	-5.4650***	-2.3435***	-4.2735***
FDI	-3.0629**	-1.7018**	-2.1582**	-11.9523***	-6.1127***	-10.1349***
INNO	4.3303	2.2376	5.3844	-12.1066***	0.2591***	-13.1856***
TO	2.9662	2.6155	2.9603	-15.9239***	-8.5944***	-14.2043***

Notes: *, **, *** indicate the significance at the 10%, 5% and 1% confidence levels, respectively.

Source: Calculated by Author.

The panel cointegration test was used based on the earlier non-stationarity test results. If the variables were non-stationary, the cointegration was then examined using Pedroni's cointegration test (1996). These cointegration tests demonstrated if a long-term link exists or not. The Pedroni test results in Table 6 demonstrated that it was not possible to rule out the null hypothesis that there is no cointegration in a diverse panel. This analysis aimed to determine whether a model for correcting errors occurred for the panel as a whole or for each panel member to check whether cointegration exists. Group-mean and panel tests are two distinct classes of tests that able to access both the alternative and null hypotheses of no cointegration. Table 6 summarised the findings of all these cointegration tests, which in every instance revealed no indication of cointegration.

Table 6 Pedroni Cointegration Test

Test Statistics	Panel (Within Dimension)		Group (Within Dimension)	
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	-0.557649	0.7115		
Panel rho-Statistic	2.471076	0.9933	3.230247	0.9994
Panel PP-Statistic	2.202397	0.9862	2.653888	0.9960
Panel ADF-Statistic	2.783586	0.9973	2.104298	0.9823

Note: Panel cointegration test includes intercept and trend.

Source: Calculated by Author.

When there is no cointegration and the variables are non-stationary, the pooled mean group panel ARDL approach can account for long- and short-term associations. The empirical findings for the ASEAN-5 economies' long- and short-term relationships between economic growth and its primary factors are shown in Tables 7 and 8, respectively.

Table 7 Full Panel ARDL Estimation of the ASEAN-5: Long-Run Coefficients

	Pooled Mean Group Estimator	
	Coefficient	Standard Error
	Long-Run Coefficients	
UI	-0.4505***	0.0636
CPI	-0.5423***	0.2030
FDI	0.6869***	0.1059
TO	-2.1077***	0.3037
INNO	0.2842***	0.0219

Notes: *, **, *** indicate the significance at the 10%, 5% and 1% confidence levels, respectively.

Source: Calculated by Author.

Table 7 demonstrated that, over the long term, all computed coefficients were correctly interpreted and statistically significant. The findings indicated that long-term economic growth suffered as a result of uncertainty. The real GDP per capita decreased by around 0.45% for every 1% increase in uncertainty, other things being equal. Inflation was also found to impact the real GDP per capita significantly negatively. An increase in the average inflation rate by1% per year was estimated to lower the real GDP growth rate per capita by 0.54% per year.

Additionally, economic production and trade openness were inversely correlated, and this link was significant statistically at the 1% threshold of significance. A 1% increase in trade openness decreased output by 2.11 % while keeping all other factors constant. The findings of this research supported the views of; Foster (2008), Simorangkir (2006) and Jin (2006) that trade liberalisation had adverse effects on economic expansion as a result of poor demand and low domestic production caused by the lack of variety in products available in the market.

Economic growth, as expected, was positively impacted at the 1% significance level by FDI and innovation, as shown in Table 7. A 1% unit increase in FDI and innovation would provide approximately 0.69% and 0.28% increases in the real GDP per capita. Economic growth would be benefited in the long run by an increase in innovation. According to what was previously discussed, FDI is crucial for advancing technology, promoting knowledge, and boosting the economy.

Table 8 presented the short-run dynamics findings. The coefficient supported a steady long-term relationship between the variables on the lag-added error correction term being substantial and with the correct sign. This coefficient showed that divergence from the production level of long-run equilibrium in one year was corrected by 11.69% in the following year. A measure of output elasticity concerning uncertainty (negatively) or FDI (positively) in the short run proved statistical significance. Uncertainty and FDI boosted economic development in the short-term. Therefore, the important findings of this study demonstrated that economic growth was significantly impacted by FDI and uncertainty in both the short- and long-term.

Table 8 Full Panel ARDL Estimation of the ASEAN-5: Short-Run Coefficients

	Pooled Mean Group Estimator	
	Coefficient	Standard Error
	Short-Run Coefficients	
ECM $_{t-1}$	-0.11687*	0.0531
ΔUI	-0.0037*	0.0146
ΔUI $_{t-1}$	-0.0025***	0.0042
ΔCPI	0.1860	0.6343
ΔCPI $_{t-1}$	0.0133	0.6553
ΔFDI	0.0061*	0.0577
ΔFDI $_{t-1}$	0.0044*	0.0512
ΔTO	-0.0118	0.3412
ΔTO $_{t-1}$	0.1473	0.2237
ΔINNO	-0.3205	0.3180
ΔINNO $_{t-1}$	-0.2851	0.3100
Constant	-0.4744	1.0065

Notes: *, **, *** indicate the significance at the 10%, 5% and 1% confidence levels, respectively.

Source: Calculated by Author.

The Wald test examined the association between the independent variables (predictors) and the criterion variable (dependent). The F-statistic in Table 9 showed less than 0.05 as the probability value. Thus, the null hypothesis was rejected as a result of the finding that a relationship existed between the variables tested.

Table 9 Wald Test

Test Statistic	Value	df	Probability
F-statistic	439.3807	(5,116)	0.0000
Chi-square	2196.903	5	0.0000

Source: Calculated by Author.

The short-run coefficients varied by country were tested and the results are displayed in Table 10. The results for each of the ASEAN-5 countries individually demonstrated that the error correction term was adverse and significant statistically at the 1% level in each of the ASEAN-5 nations, except Singapore. According to the results, most of the sampled country's returns to equilibrium were rather slow.

Table 10 Panel ARDL Estimations by Country: Short-Run Coefficients

	Pooled Mean Estimators									
	Coefficient	**S.E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**	**Coefficient**	**S.E.**
	Malaysia		**Indonesia**		**The Philippines**		**Singapore**		**Thailand**	
ECM $_{t-1}$	-0.0111***	0.0013	-0.0907***	0.0009	-0.0715***	0.0007	0.2859***	0.0018	-0.0089***	0.0005
ΔUI	-0.0433***	0.0005	0.0344***	0.0003	0.0129***	0.0004	-0.0320***	9.76E-05	0.0093***	0.0007
ΔUI $_{t-1}$	0.0021*	0.0004	-0.0161***	0.0004	-0.0018*	0.0003	-0.0058***	3.82E-05	0.0089***	0.0007
ΔCPI	0.4843	1.5308	2.4278*	0.7679	-1.1656***	0.0763	0.0386	0.2745	-0.8554	1.2229
ΔCPI $_{t-1}$	1.8133	2.3039	0.681377	0.7554	0.1367*	0.0535	-2.1568*	0.4554	-0.4081	1.1291
ΔFDI	-0.1223***	0.0045	-0.0366***	0.0019	-0.0676***	0.0003	0.2133***	0.0013	-0.0174***	0.0009
ΔFDI $_{t-1}$	-0.1522***	0.0037	-0.0205***	0.0014	-0.0053***	0.0003	0.1695***	0.0007	-0.0135***	0.0009
ΔTO	-0.7413***	0.0682	-0.034157	0.0407	0.1545*	0.0388	-0.6124***	0.0291	1.1745	10.6915
ΔTO $_{t-1}$	0.0588	0.0787	-0.131843*	0.0454	-0.2763***	0.0465	0.0833*	0.0164	1.0025	11.5148
ΔINNO	0.0763***	0.0026	-0.051419***	0.0003	-0.1030***	0.0026	0.0609***	7.29E-05	-1.5852	19.9362
ΔINNO $_{t-1}$	0.1966***	0.0035	-0.050105***	0.0003	-0.0927***	0.0028	0.0301***	6.08E-05	-1.5093	21.4576
Constant	0.0659	0.2814	0.875542*	0.1675	0.9237***	0.0894	-4.4408***	0.3135	0.2034	0.0876

Notes: *, **, *** indicate significance at 10*, 5% and 1% confidence levels, respectively.

Source: Calculated by Author.

The Granger causality test requires a long-run relationship or cointegration for a time series to pass. It was established in earlier phases of the investigation that there was a long-term link between uncertainties (e.g. the uncertainty index, CPI, FDI, trade openness and innovation) and economic growth across all panels through panel cointegration testing. This outcome demonstrated that uncertainties and growth must at least be caused in a single direction. Using the Dumitrescu-Hurlin (2012) panel causality test, Table 11 investigated the factors causing and impacting economic uncertainty for the ASEAN-5 nations.

Table 11 Dumitrescu and Hurlin Panel Causality Test

Hypothesis	W-Stat.	Zbar-Stat.	Prob.
UI does not homogeneously cause GDP	1.01982	-1.09456	0.2737
GDPC does not homogeneously cause UI	6.44341	4.45638	8.E-06
CPI does not homogeneously cause GDP	2.58383	0.52143	0.6021
GDP does not homogeneously cause CPI	6.40113	4.46673	8.E-06
FDI does not homogeneously cause GDP	2.23641	0.13904	0.8894
GDP does not homogeneously cause FDI	6.91287	4.87894	1.E-06
TO does not homogeneously cause GDP	1.90444	-0.18074	0.8566
GDP does not homogeneously cause TO	3.65453	1.62803	0.1035
INNO does not homogeneously cause GDP	4.52217	2.33159	0.0197
GDP does not homogeneously cause INNO	2.61788	0.47087	0.6377

Source: Calculated by Author.

The analysis of the test findings showed economic growth caused the CPI, FDI and the uncertainty index, but not the other way around. Furthermore, economic growth did not significantly affect innovation, whereas innovation had a major impact on economic growth. The uncertainty index, CPI, FDI, innovation, and economic growth were thus all correlated in a single direction. However, there was no reciprocal relationship between trade openness and economic growth in the sampled countries.

CONCLUSION

Despite appearing most frequently in modern theory and research literature, the term "uncertainty" and its effects on economic growth is really challenging to delineate. Economic uncertainty suggests that the economy's prospects are unknown. Economic uncertainty can be caused by supply-side shocks, demand-side shocks and financial instability.

In this study, the ASEAN-5 countries' economic growth and levels of uncertainty were compared between 1960 and 2020. A multivariate model of the GDP, uncertainty index, trade openness, inflation, foreign direct investment, and innovation was utilised to account for uncertainty's simultaneous role on the sides of supply and demand. Unit root testing (IPS, Breitung and LLC) and the Pedroni cointegration test were employed to assess unit roots and cointegration before causality testing (Dumitrescu-Hurlin test).

The pooled mean group panel ARDL model results showed long- and short-term relationships between uncertainty and economic expansion. The investigation revealed that FDI and the uncertainty index have both long-term and short-term effects on the ASEAN-5 economies' ability to grow economically. Long-term

economic growth in the ASEAN-5 economies was influenced favourably and statistically significantly by foreign direct investment and innovation, while the uncertainty index, inflation and trade openness have a long-term negative impact on economic growth. The system's error correction terms suggested that it would take the system longer than a year to reach equilibrium again. The adverse and statistically significant parameters for error correction were present for all countries when individual countries are observed, except Singapore, but the return to equilibrium was rather slow.

In addition, the findings of causality test revealed a one-way causality from economic growth to the uncertainty index, CPI and FDI in the ASEAN-5 countries. Economic expansion was significantly influenced by innovation, whereas economic expansion did not significantly influence innovation. A two-way causal relationship between these variables was not supported by any data. On the other hand, the sampled countries had no reciprocal relationship between trade liberalisation and economic growth.

The authors recommend that policymakers take caution while addressing uncertainty factors in their respective countries. It may be best to approach each case independently, in which every nation must find its means of tolerating various degrees of uncertainty. Such a strategy would be implemented based on each nation's current state of development and its social and political history.

This research focussed on the ASEAN-5 countries. Therefore, further research could be extended to the ASEAN-10 countries, developing, developed or regional countries. In such a case, academics may compare the effects of uncertainty on other nations and verify their findings. Additional research ideas include; lengthier study periods and a wider range of nations with various economic, social, and historical perspectives.

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